KERALA AGRICULTURAL UNIVERSITY

B.Tech (Agrl.Engg) 2014 Admission

II[nd] Semester Final Examination-June/July-2015

Cat. No: Phpt.1201 Marks: 50

Title: Heat and Mass Transfer (1+1) Time: 2 hours

Define the following (10x1.0 = 10.0)

1. Fourier's law
2. Radiation
3. Mass transfer
4. Fick's law
5. LMTD
6. Black body
7. Plank's law
8. Diffusion
9. NTU
10. Heat exchanger

II Write short notes on any FIVE questions (5 x 2=10)

1. Explain convective mass transfer.
2. Differentiate Grey body and Black body.
3. Prove that the heat loss per square metre of outside surface of a hollow sphere heated from inner sphere is equal to $2K(t_1 - t_2)/(D_2-D_1)(D_2/D_1)$ where, t_1 and t_2 are temperatures and D_1 and D_2 are inner and outer diameters.
4. Exhaust gases flowing through a parallel flow tubular heat exchanger at the rate of 20 kg/minute are cooled from 450°C to 150°C by water initially at 20°C. The specific heat of gases may be taken as 1.13 kJ/kg K, and overall heat transfer co-efficient may be taken as 140 W/m^2. Calculate the surface area needed if the water flow is 25 kg/minute.
5. A hollow steel sphere of radii 24 cm and 32 cm contains 100 watts electrical heating element. The inner and outer surface film coefficient of heat transfer are 30 and 10 W/m°K. Neglecting the thermal resistance of the metal and assuming a steady state, determine the internal temperature, if the outside temperature is 22°C.
6. Derive the relationship for the determination of heat transfer rate in a hollow sphere heated internally. Use usual notations.
7. Explain the working principles of a heat exchanger.

III Write short essays on any FIVE questions (5 x 4=20)

1. Derive an equation for determining the film heat transfer coefficient in forced convection by dimensional analysis.
2. Derive an expression for steady state heat flow through a sphere.
3. A flat composite plate is made of two layers of aluminium & steel of 5 cm & 2 cm thickness respectively. The thermal conductivities of aluminium & steel are 205 W/mK & 45W/mK respectively. The hot surface of aluminium side is in contact with hot liquid at 200°C, the heat transfer co-efficient of liquid being 29 W/ m^2K. Determine (i) over all co-efficient of heat transfer, & the heat transfer rate from the hot liquid to cold liquid through surface area of 10 m^2.
4. A mixture of helium and nitrogen gas is combined in a pipe at 298 K and 1 atm. Total pressure which is constant throughout. At one end of pipe at 0.1 the partial pressure of helium is pa_1 is 0.6 atm. and at the other end located at 20cm apart is pa_2 is 0.2 atm. Calculate the flux of helium at steady state is D_{AB} of helium and nitrogen mixture is 0.687cm^2 per second.
5. A steel ball of 5 cm diameter with initial temperature of 450°C is suddenly placed in a controlled environment in which the temperature is maintained at 110°C. Calculate the time required for the ball to attain a temperature of 150°C. Assuming k=35 W/m K. C=0.46 KJ/kg ° K and ρ = 7800 kg/m^3 steel.
6. The heat transfer coefficient including convection and radiation in 30 Kcal/hrm^2°C for the outer surface of the pipe in a large enclosure. Assuming the pipe surface is at 200°C and can be considered as a black body, calculate the radiation heat transfer coefficient. The walls of the enclosure are at 100°C. Also find the heat transfer coefficient by convection.
7. Exhaust gases flowing through the tubular heat exchanger at the rate of 20 kg/min are cooled from 450°C to 150°C by water initially at 20°C. The specific heat of gases may be taken as 1.13 kJ/kg K, and overall heat transfer co-efficient may be taken as 140 W/m^2. Calculate the surface area needed if the water flow is 25 kg/minute for a parallel flow heat exchanger.

Part-D

Answer any ONE question (1 x 10.0 =10.0)

1. Derive an equation for heat transfer by conduction in lagged pipe.
2. A surface condenser receives 14 000kg/hr of steam at 0.1 bar and 0.8dry. All the steam is condensed by the cooling water which enters at 20□C and leaves at 40□C. the condenser tubes are 2 cm outer diameter, and the co-efficient of heat transfer from steam to tubes and tubes to water can be taken as 4650 and 3490 W/m^2K respectively, both based on the tube outer diameter. The tube thickness is 1 mm and the co-efficient of conductivity is high and hence its resistance can be neglected. Water flows across the tubes two times (two pass condenser) and velocity is 2.5 m/sec Determine the number of tubes and the length of tube between tube end plates assuming it to be counter-flow.

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